

WHAT IS CLAIMED IS:

1           1. An integrated circuit incorporating an Electrostatic Discharge (ESD)  
2 protection device comprising:  
3           a semiconductor substrate;  
4           an electrical contact pad;  
5           an ESD switch coupled to the pad and having an active device region  
6 formed in the semiconductor substrate; and  
7           a dynamic shock absorbing region formed in the semiconductor  
8 substrate adjacent to said active device region, said dynamic shock absorbing  
9 region made from a material with thermo-mechanical properties substantially  
10 more resistant to shock from dynamic effects of ESD than said active device  
11 region.

1           2. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 1, wherein said thermo-  
3 mechanical properties include a dynamic loss factor higher than  
4 approximately 0.01.

1           3. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 1, wherein said thermo-  
3 mechanical properties further include a melting temperature higher than  
4 approximately 800 °K.

1           4. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 1, wherein said thermo-  
3 mechanical properties further include a moderately low stiffness as defined by  
4 an elastic modulus approximately in the range of 10 GPa and 100 GPa (Giga  
5 Pascals).

1           5. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 1, wherein said thermo-  
3 mechanical properties further include a tensile strength higher than  
4 approximately 100 MPa.

1           6. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 1, wherein the ESD switch has  
3 one or more sides, and wherein the dynamic shock absorbing region formed  
4 in the semiconductor substrate is located in trenches adjacent to the one or  
5 more sides of the ESD switch.

1           7. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 1, wherein the ESD switch is a  
3 transistor.

1           8. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 1, wherein the dynamic shock  
3 absorbing region is configured above the active device region.

1           9. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 1, wherein the dynamic shock  
3 absorbing region is configured below the active device region of the ESD  
4 switch.

1           10. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 1, wherein said dynamic shock  
3 absorbing region made from a material with thermo-mechanical properties  
4 substantially more resistant to dynamic shock than said active device region is  
5 selected from the group consisting of hard polymers, amorphous carbon,  
6 carbon-carbon composite or carbon-polymer composite.

1           11. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 1, wherein said dynamic shock  
3 absorbing region is surrounded by a dielectric region.

1           12. An integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device comprising:  
3           a semiconductor substrate;  
4           an ESD switch having an active device region formed in the  
5 semiconductor substrate; and  
6           a plurality of dynamic shock absorbing regions formed around the  
7 active device region, said dynamic shock absorbing region made from a  
8 material with thermo-mechanical properties substantially more resistant to  
9 shock from dynamic effects of ESD than said active device region.

1           13. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 12, wherein said thermo-  
3 mechanical properties include a dynamic loss factor higher than  
4 approximately 0.01.

1           14. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 12, wherein said thermo-  
3 mechanical properties further include a melting temperature higher than  
4 approximately 800 °K.

1           15. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 12, wherein said thermo-  
3 mechanical properties further include a moderately low stiffness as defined by  
4 an elastic modulus approximately in the range of 10 GPa and 100 GPa (Giga  
5 Pascals).

1           16. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 12, wherein said thermo-  
3 mechanical properties further include a moderately high tensile strength  
4 higher than approximately 100 MPa.

1           17. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 12, further comprising a dielectric  
3 layer formed in between said ESD switch and said dynamic shock absorbing  
4 region.

1           18. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 12 and further comprising a  
3 passivation layer formed above said dynamic shock absorbing region.

1           19. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 12, wherein said ESD switch has a  
3 gate region and wherein said gate region is formed from a thermo-mechanical  
4 energy sink material, said thermo-mechanical energy sink material  
5 substantially more resistant to thermo-mechanical expansion than the  
6 semiconductor substrate.

1           20. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 19, wherein said thermo-  
3 mechanical energy sink material has physical properties including a high  
4 melting temperature higher than approximately 2000 °K.

1           21. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 19, wherein said thermo-  
3 mechanical energy sink material has physical properties further including a  
4 high tensile strength higher than approximately 300 MPa.

1           22. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 19, wherein said thermo-  
3 mechanical energy sink material has physical properties further including a  
4 low thermal expansion coefficient lower than approximately  $5 \times 10^{-6} \text{ }^{\circ}\text{K}^{-1}$ .

1           23. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 12, further comprising a second  
3 dynamic shock absorbing region formed in the semiconductor substrate in  
4 thermal contact with said active device region, said second dynamic shock  
5 absorbing region made from a material with thermo-mechanical properties  
6 substantially more resistant to shock from the dynamic effects of ESD than  
7 said active device region.

1           24. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 12, wherein the ESD switch has  
3 one or more sides, the device further comprising a third dynamic shock  
4 absorbing region located adjacent to the one or more sides of the ESD switch.

1           25. An integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device comprising:  
3           a semiconductor substrate;  
4           an ESD circuit comprising a switch having an active device region  
5 formed in the semiconductor substrate and one or more passive circuit  
6 components; and  
7           means for absorbing dynamic shock from at least one of the switch and  
8 one or more passive components in response to an ESD event.

1           26. An integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 25, wherein said means for  
3 absorbing shock comprises a region above the active device region made  
4 from a material with thermo-mechanical properties resistant to shock from

5 dynamic effects of ESD, the thermo-mechanical properties including a high  
6 material dynamic loss factor higher than approximately 0.01.

1 27. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 25, and further comprising a  
3 second dynamic shock absorbing region formed below the active device  
4 region, said second dynamic shock absorbing region made from a material  
5 with thermo-mechanical properties resistant to shock from the dynamic effects  
6 of ESD, the thermo-mechanical properties including a high material dynamic  
7 loss factor higher than approximately 0.01.

1 28. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 25, wherein the ESD switch also  
3 has one or more sides, wherein the means for absorbing shock further  
4 comprises a third dynamic shock absorbing region formed adjacent to the one  
5 or more sides of the ESD switch, said third dynamic shock absorbing region  
6 made from a material with thermo-mechanical properties resistant to shock  
7 from the dynamic effects of ESD, the thermo-mechanical properties including  
8 a high material dynamic loss factor higher than approximately 0.01.

1 29. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 25, wherein said ESD switch has a  
3 gate region and wherein said gate region is formed from a thermo-mechanical  
4 energy sink material, said thermo-mechanical energy sink material  
5 substantially resistant to thermo-mechanical expansion and having physical  
6 properties including a low thermal expansion coefficient lower than  
7 approximately  $5 \times 10^{-6} \text{ }^{\circ}\text{K}^{-1}$ .

1 30. The integrated circuit incorporating an Electrostatic Discharge  
2 (ESD) protection device according to claim 25, wherein said active device  
3 region is formed from a thermo-mechanical energy sink material, said thermo-  
4 mechanical energy sink material substantially resistant to thermo-mechanical

5 expansion and having physical properties including a low thermal expansion  
6 coefficient lower than approximately  $5 \times 10^{-6} \text{ }^{\circ}\text{K}^{-1}$ .

1           31. A method of fabricating an ESD device on a semiconductor  
2 substrate, the method comprising:  
3           fabricating a switch from connectors and active device regions formed  
4 in the semiconductor substrate;  
5           providing a dynamic shock absorbing region formed in the  
6 semiconductor substrate adjacent said active device regions, said dynamic  
7 shock absorbing region made from a material with thermo-mechanical  
8 properties substantially resistant to shock from dynamic effects of ESD.

1           32. A method of fabricating an ESD device on a semiconductor  
2 substrate according to claim 31, wherein said thermo-mechanical properties  
3 including a high material dynamic loss factor higher than approximately 0.01.

1           33. The method of fabricating an ESD device on a semiconductor  
2 substrate according to claim 31 wherein said thermo-mechanical properties  
3 further include a moderate melting temperature material higher than  
4 approximately 800 °K.

1           34. The method of fabricating an ESD device on a semiconductor  
2 substrate according to claim 31, wherein said thermo-mechanical properties  
3 further include a moderately low stiffness as defined by an elastic modulus  
4 approximately in the range of 10 GPa to 100 GPa (Giga Pascals).

1           35. The method of fabricating an ESD device on a semiconductor  
2 substrate according to claim 31, wherein said thermo-mechanical properties  
3 further include a moderately high tensile strength higher than approximately  
4 100 MPa.